Table 8–3. Criteria and considerations for collecting a representative sample of bottom material

Aspects of sample collection	Criteria and considerations
Equipment	• Sampling equipment penetration must be deep enough to provide a sample that meets project objectives. • Sampling equipment must be completely closed after proper penetration. • Weight of sampler (too light could produce improper deployment of sampler).
Techniques and methods	• Bottom-material disturbance prior to equipment deployment must be avoided. • Quantities of bottom material enclosed each time sampling equipment is deployed should be approximately equal. • Speed of sampler through water column (too fast will produce too large a shock wave in front of descending sampler and greater potential for sampler malfunction, but too slow could produce insufficient penetration, especially with core samplers).
Sampling environment	• Depth of water column (ensure adequate cable length to control speed of sampler deployment and personal safety when wading). • Physical, chemical, and biological character of water column above sample-collection site (especially presence or absence of oxygen). • Velocity of water currents (too fast could produce improper deployment of sampler). • Sampling platform stability (such as boat, ice, float plane).

8.4.1 SAMPLING PROCEDURES

Bottom-material samples must meet the sampling objective of the study. Use procedures that minimize sample disturbance and prevent contamination. Be aware that no procedure for collecting bottom-material samples can be used for every type of study objective and environmental setting.

Complete the following steps before beginning to sample:

1. Select sampling locations (refer to section 8.2 and table 8–4).

   a. Examine each site to be sampled in a manner that minimizes the site's problematic characteristics and maximizes its beneficial characteristics.

      - For perennial flowing water, consider collecting bottom-material samples after extended low-flow periods.
      - For ephemeral flowing water, consider collecting bottom-material samples just after a runoff event.

b. Inspect the body of water visually and bathymetrically.
   - Observe (or refer to historical information on) size and shape of the area, land use, tributary and runoff characteristics, geology, point and diffuse sources of contamination, hydraulics, water depth, and fluvial-sediment transport characteristics.
   - Use aids for site inspection, such as side-scan sonar, sub-bottom profiler or acoustic survey (echo, seismic reflections and refraction), or reconnaissance sampling.

c. Determine number of subareas according to the accuracy required by study objectives.
   - If a transect is split by natural or manmade barriers, treat each channel as a separate entity.
   - Use the two-step method described in the TECHNICAL NOTE in section 8.2.2 to obtain a statistically based estimate of the appropriate number of subareas.

d. If using statistical design methods, divide the site into numbered subareas with a sampling point located in each subarea. Collect samples in the center of numbered sites that correspond to random numbers when using stratified random, stochastic random, or systematic regular methods for design of a sample-collection network.

e. Use global positioning equipment and detailed maps to indicate site location and subareas or their sampling points.

2. Select, assemble, and set out the proper sampling, support, and safety equipment (such as floatation jackets, cable cutter, cones, signs, buoys).
   - Use quality-assured sample containers (jars, bottles, or cartons) supplied by the USGS National Water Quality Laboratory (NWQL) or QWSU.
   - Ensure that the weight of a sampler is sufficient to allow proper penetration into the bottom and deployment.
   - Sampler cable or line must be properly secured to sampling platform and sampler in order to avoid losing the sampler.
   - Limitations of using scuba gear are depth, visibility, currents, and personal safety.

Great care must be exercised when using multipurpose equipment for bottom-material sampling and sample processing. Consider following the Clean Hands/Dirty Hands technique described in Horowitz and others (1994) when using metal support equipment.

Table 8–4. Procedures for selecting sampling locations using selected nonstatistical and statistical methods

Method	Procedure
Nonstatistical method	
Deterministic	1. Divide total area to be sampled into subareas, using site-characteristics information, study objectives, and professional judgment. 2. Select location and number of subareas within total area on predetermined non-random, biased criteria.
Statistical methods	
Stratified random	1. Divide total area to be sampled into numbered subareas, using site-characteristics information, study objectives, and professional judgment. 2. Determine number of subareas required for sampling. 3. Select subareas using random numbers. 4. Collect sample in center of subarea (sampling point) that corresponds to a random number.
Stochastic random	1. Divide total area to be sampled into equally sized and numbered subareas. 2. Determine number of subareas required for sampling. 3. Select subareas using random numbers. 4. Collect samples in center of numbered subareas (sampling point) that correspond to random numbers.
Systematic regular	1. Divide total area to be sampled into regularly spaced subareas. 2. Determine number of subareas required for sampling. 3. Select subareas using random numbers. 4. Sample at center of each subarea (sampling point), keeping a constant distance between sampling locations.
Fixed transect	1. Sample along a transect at fixed and predetermined subareas (sampling points). These do not need to be at constant intervals. Sampling points can be established to coincide with the location of equal-width-increment (EWI) water sampling verticals. 2. Visually inspect body of water from bank to bank, observing and noting velocity, width, and depth distribution, as well as apparent distribution of sediment in cross section. 3. Determine width from a tagline or from increment markings on cableways or upstream bridge railings. 4. Decide minimum number of increments needed to adequately define bottom material through the transect and also to satisfy study needs and objectives. Where feasible, use a minimum of 10 EWI increments.

Begin sampling after sampling points have been located and equipment set up:

1. Move sampling and support equipment to the first station (sampling point) to be sampled and to each subsequent sampling point, in order, as samples are collected.

   - Avoid disturbance to bottom material at sampling points, caused by wading, movement of vessel and motor, and mixing or compaction of bottom material. Sample disturbance can result from a pressure wave from sampler, frictional resistance during penetration of bottom by sampler, skewed sampler penetration of bottom, and loss (washout) of sample during retrieval.
   - If wading, always approach sampling point from downstream.

2. Make field measurements in water column above sampling point to determine physical, chemical, and biological character of water (especially presence or absence of oxygen). To minimize disturbance to bottom material, make such measurements after collecting bottom-material samples (this precaution applies especially if transect will be waded).

3. Collect samples.

   If using a grab sampler:

   a. Cock bucket in open position.

   b. Steadily lower sampler to bottom, avoiding any jerking motions that would cause the cable to slacken and the bucket to close prematurely.

   c. Upon impact with bottom, tension on suspension cable or handline will be released, allowing spring-loaded sample bucket to scoop a sample. (With some grab samplers, sample bucket most often scoops sample from bottom as sampler is lifted. Therefore, sampler should be lifted slowly to allow bucket to close on the sample before raising it quickly to water surface.)

   d. Discard sample and resample if grab sampler did not close completely or if there was an obvious loss of fine material.

CAUTION: Keep hands away from the opening of the sampling bucket at all times!

If using a core sampler:

a. Use box corers in a similar manner as grab samplers and use gravity, piston, and vibracorer samplers as described by the manufacturer. (Gravity corers generally are not recommended for flowing waters.)

b. Use hand coring when wading or when using scuba gear in nonwadeable water.

   - When wading, place sampler on bottom and capture bottom material by pushing sampler into bottom. Avoid hammering.
   - Carefully retrieve hand corer and immediately cap it to prevent loss of sample.
   - If a core liner is used, remove liner from corer and stopper both ends.

4. Resample if much of the fine-grained material is lost during sampler retrieval.

5. Transfer samples from sampler to either an appropriate sample container or appropriate compositing device using nonreactive utensils and containers and the instructions in section 8.5. Before transferring any extruded core material to an appropriate container, proceed as directed in section 8.5. Repeat for samples collected from each sampling point. Field extrusion is not recommended.

   - When transferring sample from sampler to a nonreactive, appropriate sample container or compositing device, ensure that all particles are removed and transferred.
   - When transferring sample aliquots from sampler to sample container, ensure that each subsample is “representative.”

6. Repeat sample-collection procedure at each sampling point across the transect.
   - You will need to collect and homogenize at least three replicate grab samples or three subsamples from a core at each sampling point to make defensible statistical inferences. More replicates may be necessary to achieve a desired level of precision.
   - A composite of an entire core length generally is not recommended.
7. Label each sample container with the following information:
   - Station/sampling point number and name.
   - Date.
   - Mean time and gage height (or discharge) for period of sample collection.
   - Station/sampling point location, such as bridge and tagline.
   - Depth of water at sampling point.
   - Sample collection method, sampler used, analyses requested, and other information requested by laboratory performing sample analysis.
   - Number of samples in container if samples are composited.
   - Initials of sample collector.
8. Read and record gage height and time at which sample collection was completed.
9. Complete sample processing and preservation, where applicable. Refer to section 8.5.
10. Calculate and record in field notes the mean time and gage height for the period of sample collection. In field notes, record texture, color, odor, and any other characteristics of the bottom material.
11. Disassemble samplers for decontamination or routine cleaning. Decontaminate samplers as described in section 8.3.2. Always store grab samplers in the closed position.